Status of Jet Corrections in Run II

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Collaboration Meeting
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- Limited Scope:
  Provide jet corrections for basic JETCLU algorithm
- Improved resolution (di-jet group, see later) and/or systematics, to be dealt with separately on a longer time scale.

Follow Run I method to provide corrections for summer physics

1. Check Calorimeter E-scale.
2. Tune simulation to reproduce test beam data + low E_T pions in TeV data.
3. Tune jet fragmentation(charged particles) in Monte Carlo to reproduce tracks in jets.
4. Use Monte Carlo to go from particles to jets.
5. Derive all the correction functions for a Run II JTC96X.

Jet Corrections in Run I

The corrections applied to raw cluster energies are :

$$P_T(R) = (P_T^{raw}(R) \times f_{rel} - UEM(R)) \times f_{abs}(R) - UE(R) + OC(R). \quad (1)$$

Here R=$\sqrt{(\Delta\eta)^2 + (\Delta\phi)^2}$ is the cone radius chosen for the jet measurement; R=0.4 for top analysis. The corrections are:

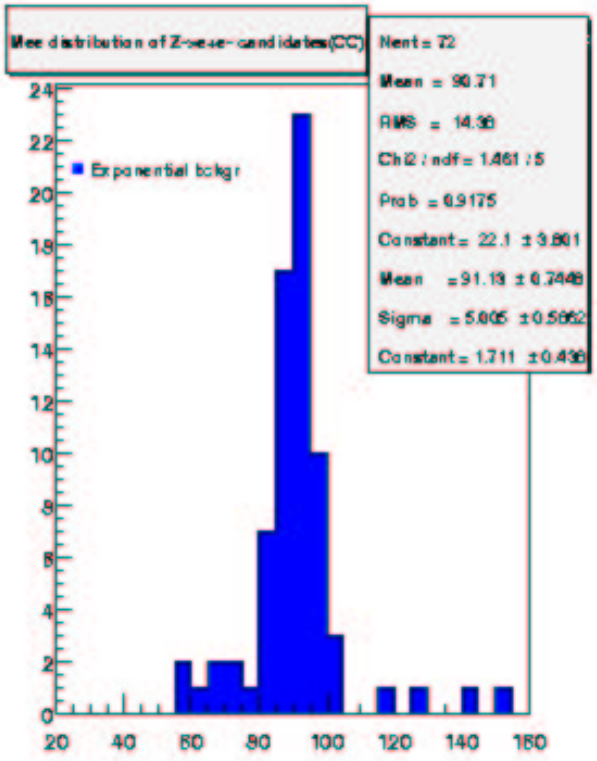
- f_{rel}, the relative energy scale. Corrects for non-uniformities in calorimeter response as a function of η.
- $UEM(R)$ subtracts the energy due to multiple interactions.
- $f_{abs}(R)$, the absolute energy scale. Maps the raw jet energy observed in a cone of radius R into the average true jet energy. This average is determined in the central calorimeter assuming a flat $\mathrm{P_T}$ spectrum.
- $UE(R)$ takes into account the energy due to the underlying event. In Run I minbias events were used for this correction.
- $OC(R)$, corrects for the energy expected to be outside the radius R.

The $f_{abs}(R)$ and $OC(R)$ corrections are functions of the transverse momentum of the jet. The relative correction has only a weak dependence on jet P_T .

Status of Calorimeter E-scale

1. CEM and PEM Energy scale

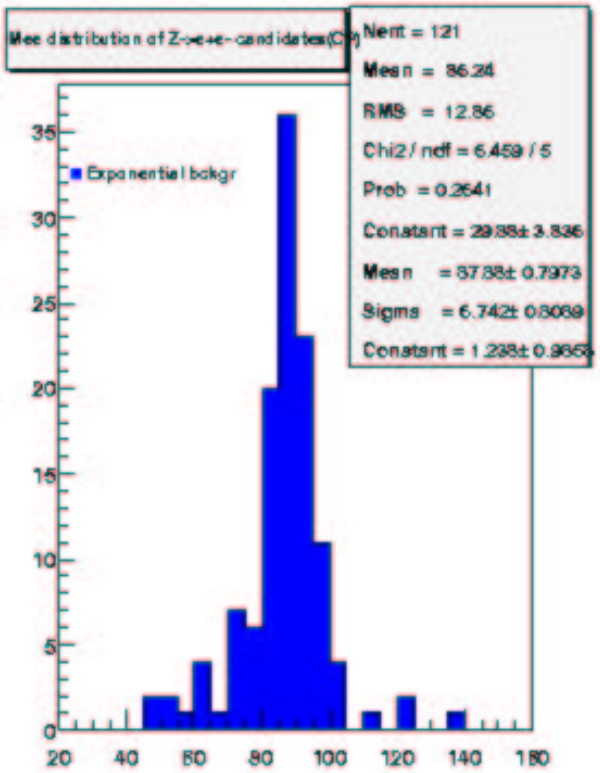
We have Z $\rightarrow e^+e^-$ from the ETF work. Fit by Mircea Coca.



Z mass for CEM-CEM electrons

M(Z)=91.1 $\pm$0.7 GeV

$\Delta(E)_{CEM} \sim 0$



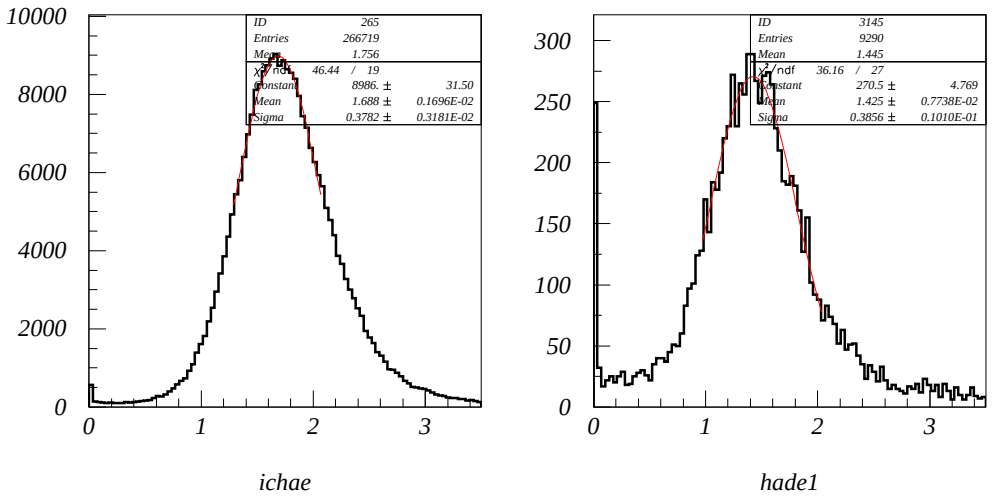
Z mass for CEM-PEM electrons

MZ=87.9 $\pm$0.8 GeV

$\Delta(E)_{CEM} = -7.2\%$

2. CHA Energy scale

MIP peak from $J/\psi \rightarrow \mu\mu$ (Robyn Madrak)



CHA peak for J/ψ muons

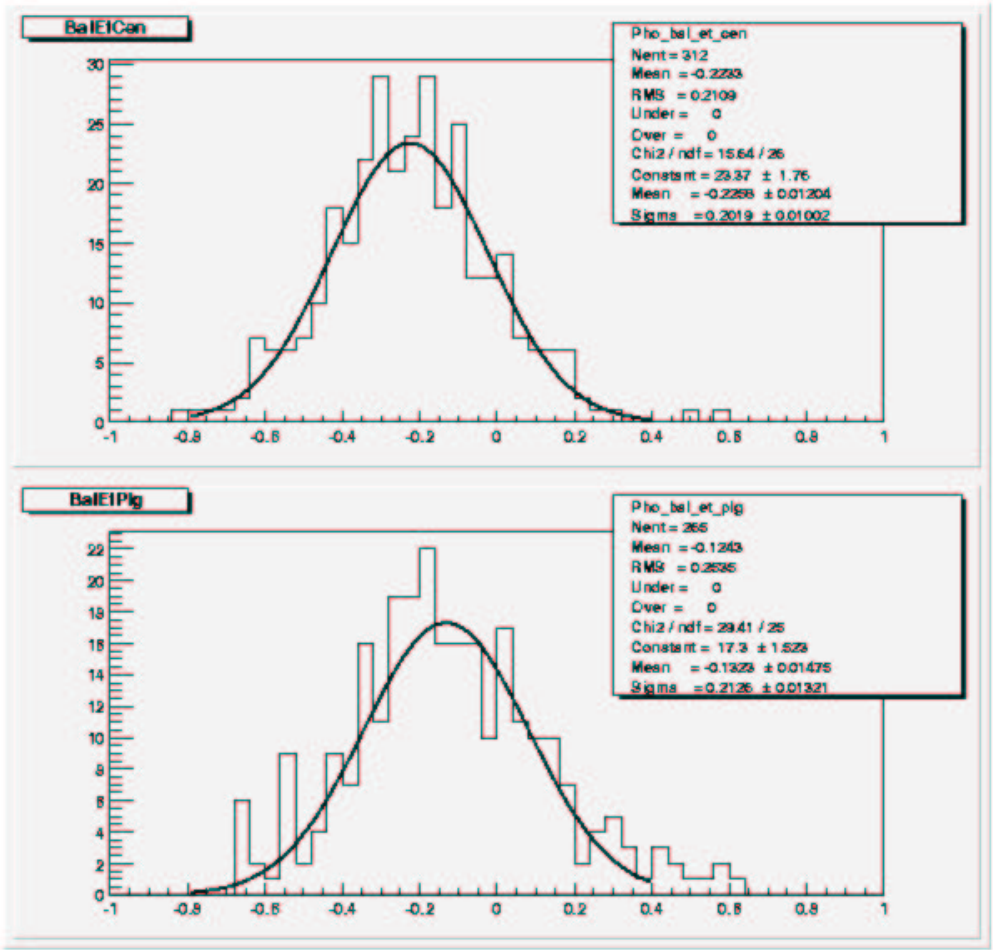
MIP = 1.688 ± 0.002 GeV Run I

MIP = 1.661 ± 0.002 GeV Run II, after Dec. 10 (green)

$\Delta(E)_{CHA}$ = (-2.0 ± 1.0)%

3. γ-jet balance

Compare run II with Run I with no correction on jets (Latino/Heinemann):



Central Calorimeter jets

DP_T/P_T = -(19.4 ± 0.1)% Run I

DP_T/P_T = -(22.6 ± 1.2)% Run II

$\Delta(P_T/P_T)_{jets}$ = -(3.2 ± 1.2)%

Plug Calorimeter jets

DP_T/P_T = -(13.2 ± 1.5)% Run II

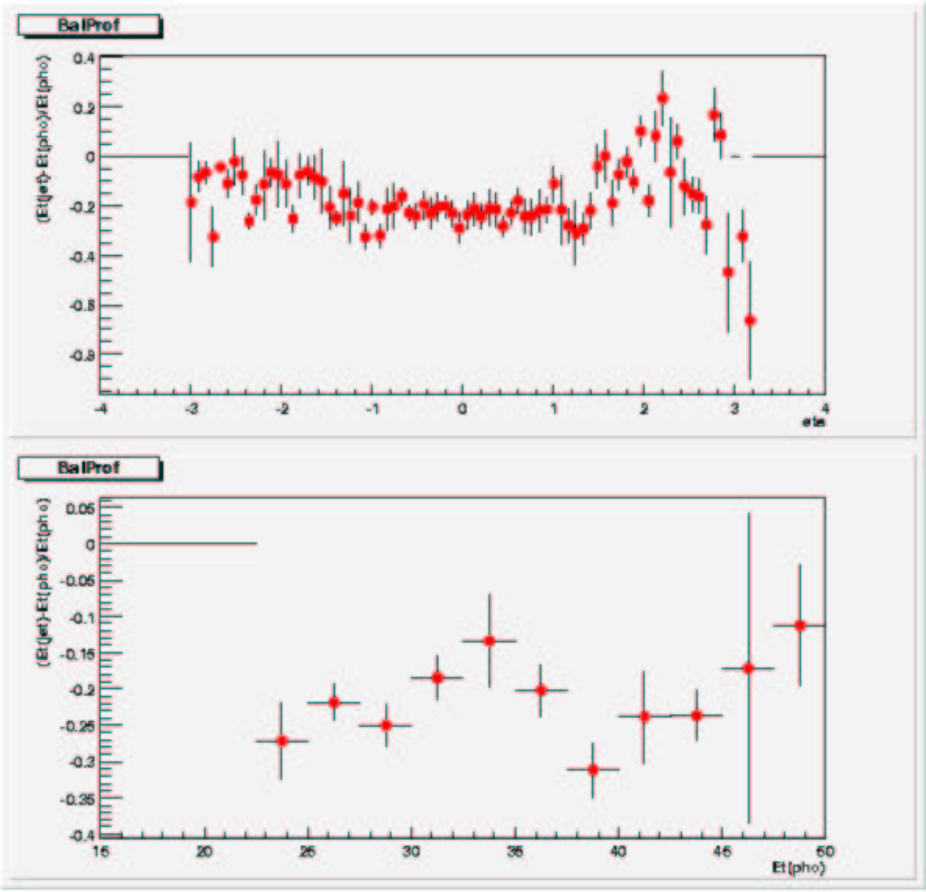
$\Delta(DP_T/P_T)_{P-C}$ = +(9.4 ± 1.9)%

Plug has higher response than central.

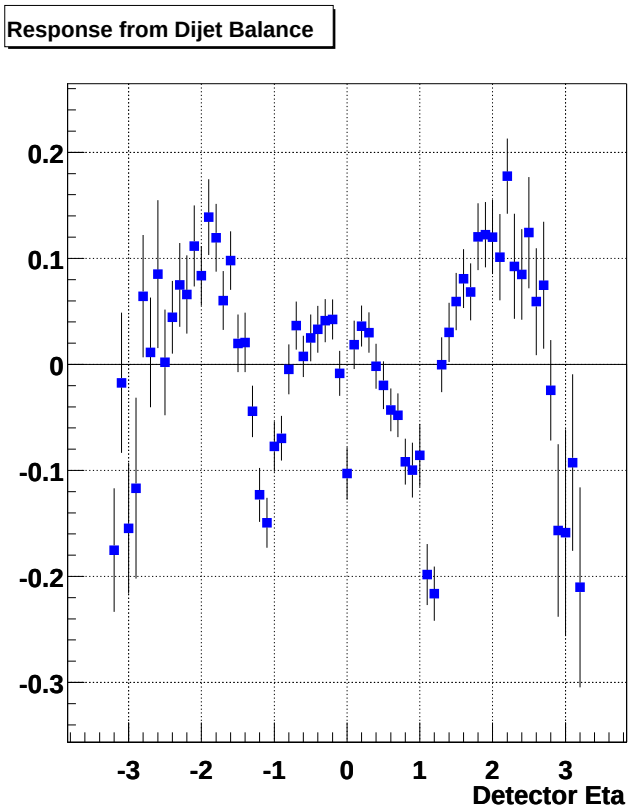
Is it E-scale problem or just different calorimeter response?

4. Di-jet balance: η dependence

Use γ-jet balance and di-jet balance to get relative correction.
The two sets of data (taken after Dec. 10) should be consistent.



γ-jet balance (Giuseppe/Beate)



di-jet balance (Gene Flanagan/RobertH)

Results consistent with plug response being higher by $\sim$ 10%.

γ-jet balance shows asymmetry in the East-West plug, but smaller data sample.

5. Conclusion on Calorimeter E-scale

- CEM looks OK (from Z's)
- CHA very close, -(2.0 $\pm$ 1.0)% (from J/ψ muons)
- PEM shifted by -7.2% (from Z's)

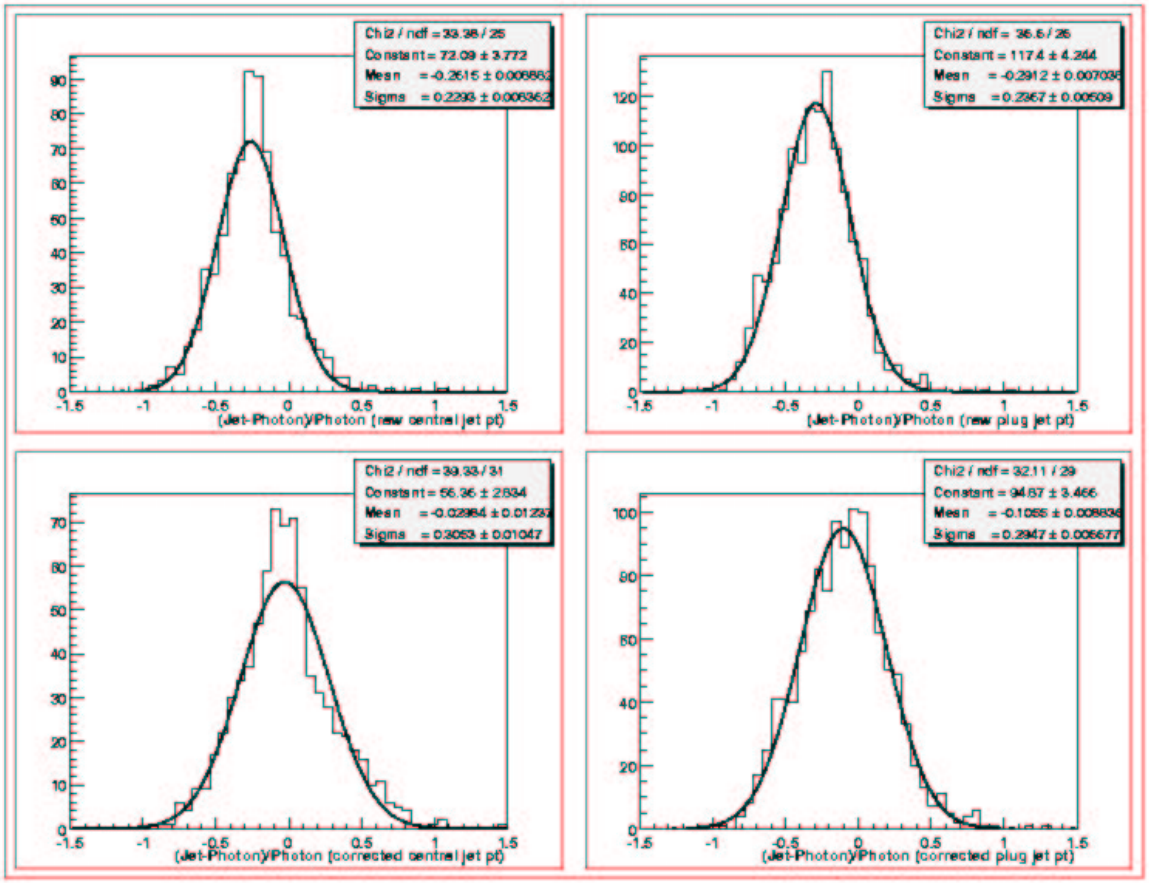
- Central jets: shifted by $\sim$ -3% (from γ-jet balance).
- Plug jets: higher than central by $\sim$ 10% (from γ-jet balance and di-jet balance)

The above results imply that the PHA has a higher response than the CHA.

- Need pions and muons in the plug.
- Need a tuned Monte Carlo to understand the expectations for plug jets.

6. Can we use the Run I corrections?

The central calorimeter E-scale is consistent with run I within a few %.



The lower left plot shows that for Central jets using the Run I corrections we can achieves a γ-jet balance within a few % (Steve Kuhlmann).

We can expect a (5-10)% uncertainty if we proceed this way.

Simulation Tuning (GFLASH)

Simulation tuning is a high priority because:

- It is necessary for checking absolute calibration.
- It is important for generating Monte Carlo events for physics studies.

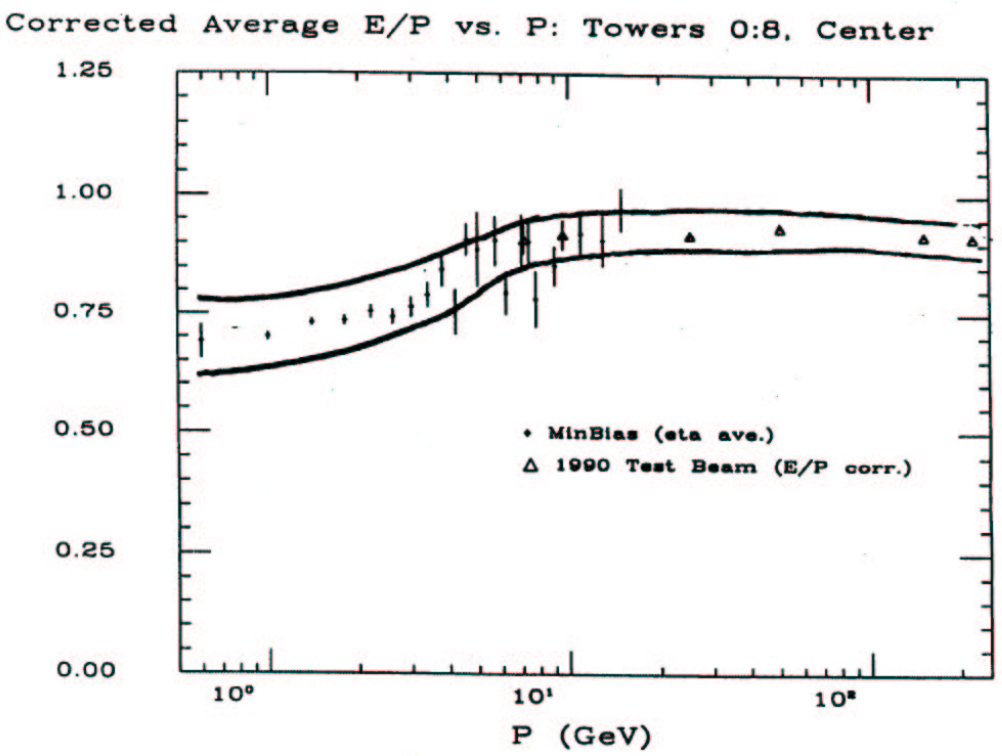
Data to be used is:

- Test beam data for Central and Plug Calorimeters (∼10-227 GeV).
- Low energy pions (0.5-12 GeV). Large range needed to overlap with test beam data (non-linearity).

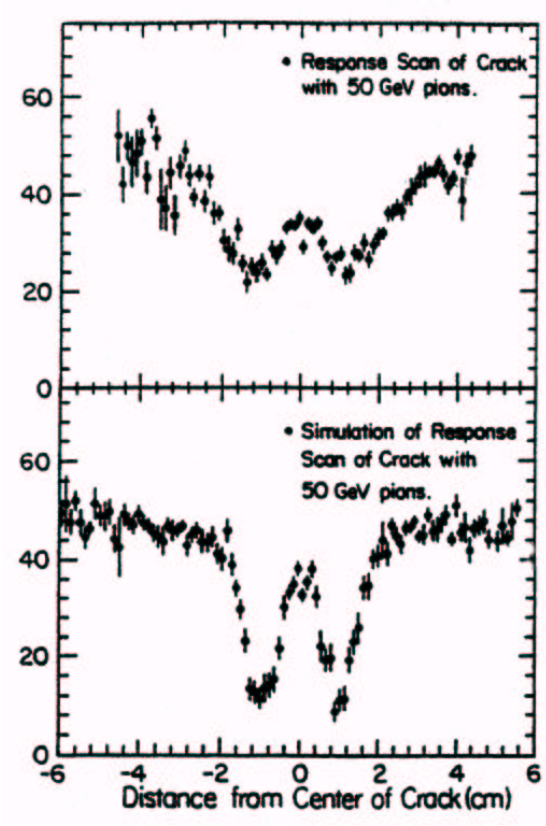
1. Simulation tuning Effort
   - Central: low PT tracks, lateral shower shape (Ricardo Eusebi).
   - Central: test beam data (Soon Yung Jun).
   - Plug EM : electrons E/P (Erik Brubaker).
   - Plug face response (Henri Bachacou).
   - Plug hadron (Charles Currat).

2. Low P_T tracks response

- isolated tracks in minbias data (Pt $\geq$ 0.5 GeV) (Sarah Demers).
- special trigger to cover 3-10 GeV region (Mel/Matt Baumgart).
- Studying leakage in nearby towers (Sarah).
- Studies of crack losses (Sarah).



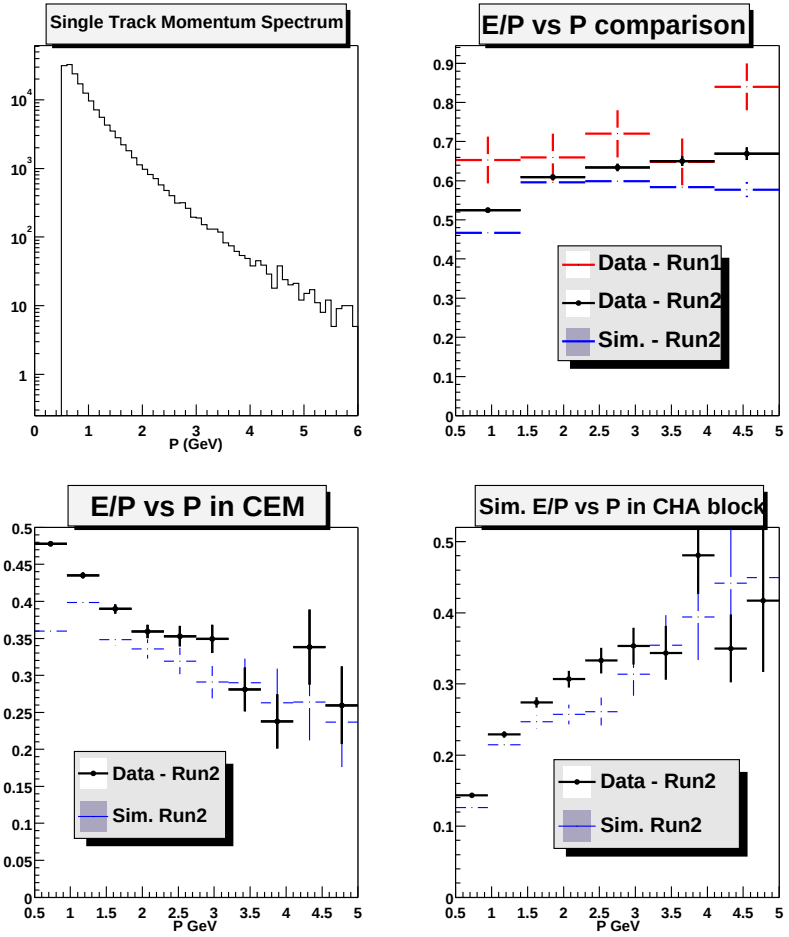
Run I pion response in Central



Run I pions: ϕ cracks in Central

3. Low P_T tracks response results

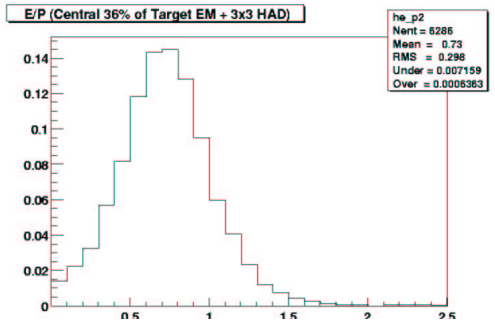
Analyzed 20% of data after Dec. 10 (Sarah Demers)

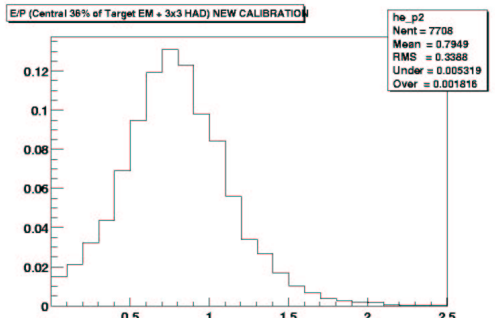


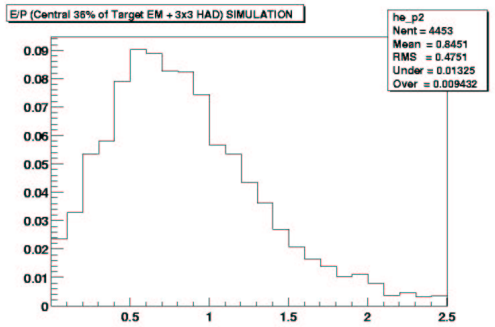
E/P, compared with Run I, seems to be (5-10)% low
(just off the presses, so caution)

Simulation is old tuning.
Tuning the latest version is in progress.

4. Low P_T tracks response results(cont.)







Isolated tracks above 4 GeV.
(Mel/Matt Baumgart)

New triggers setup to increase statistics above 4 GeV.

E/P for Isolated tracks in 4 GeV bin shown.

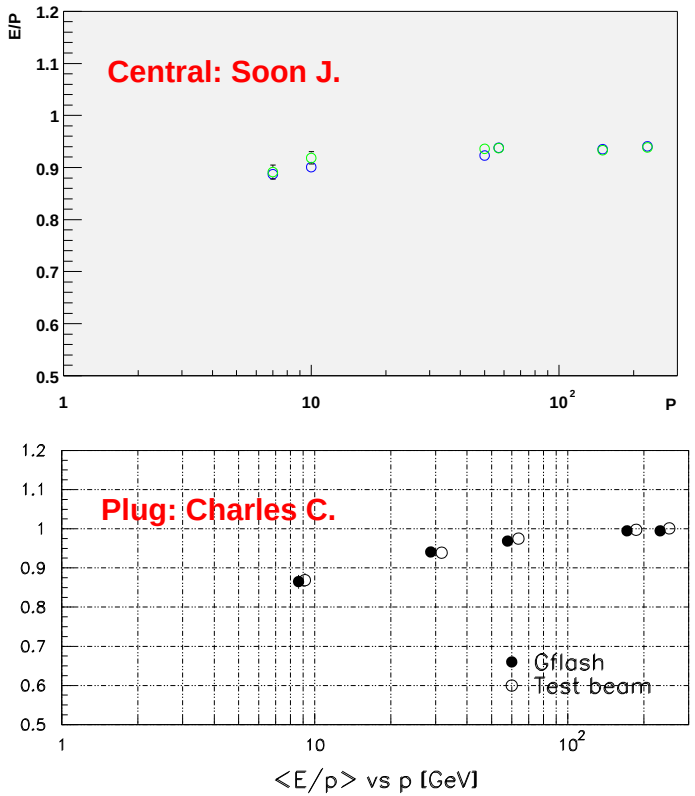
Data after Dec. 10 shows a clear shift.

Old simulation shown. Data can now be used for simulation tuning.

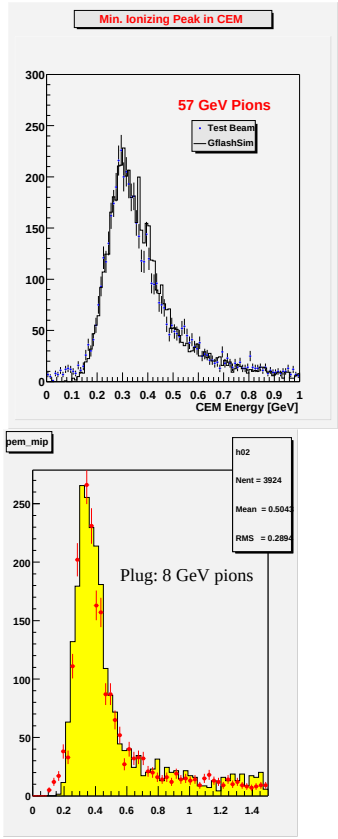
5. Test beam data tuning results

Recently a problem with MIP response was fixed in the code (Soon, Charles).

- Both CHA and PHA tuning complete (CDF note being written).

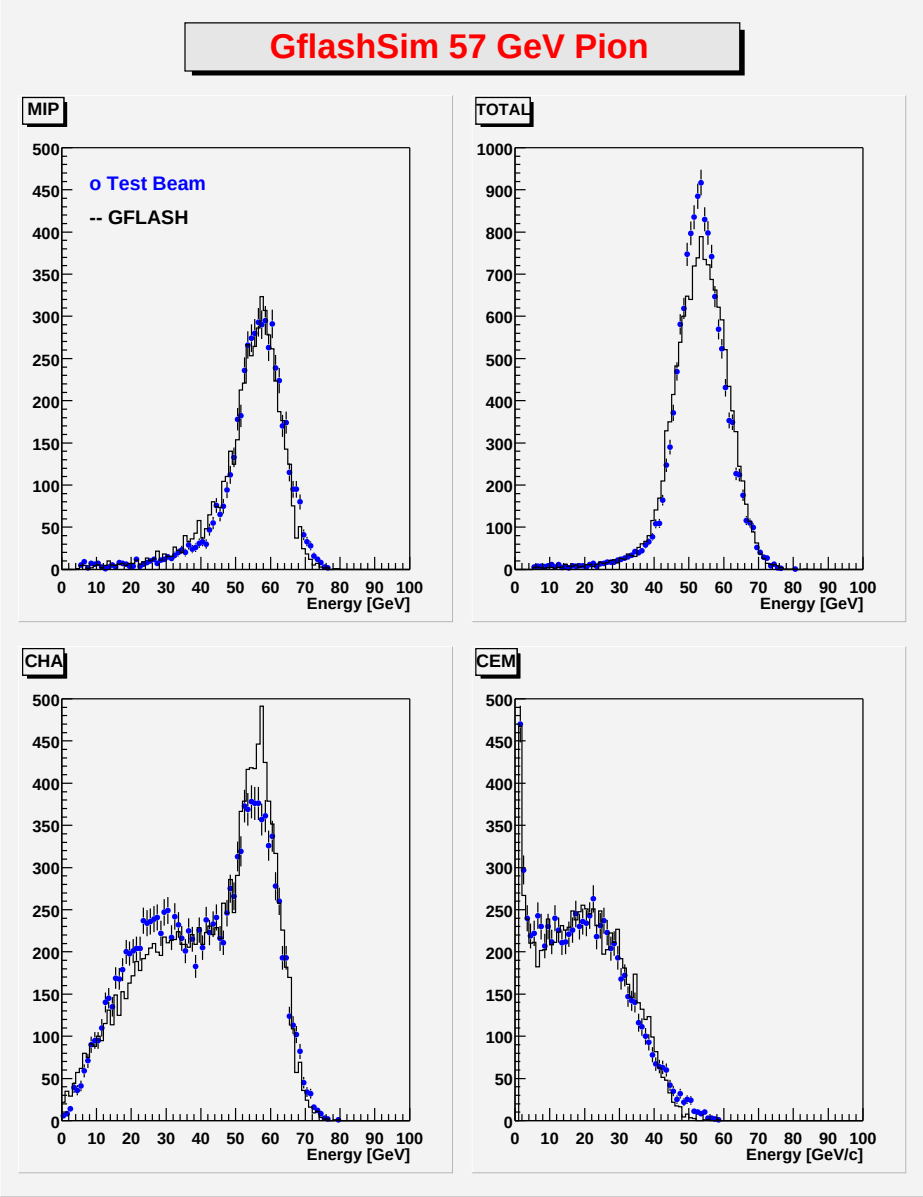


Comparison of data and Monte Carlo

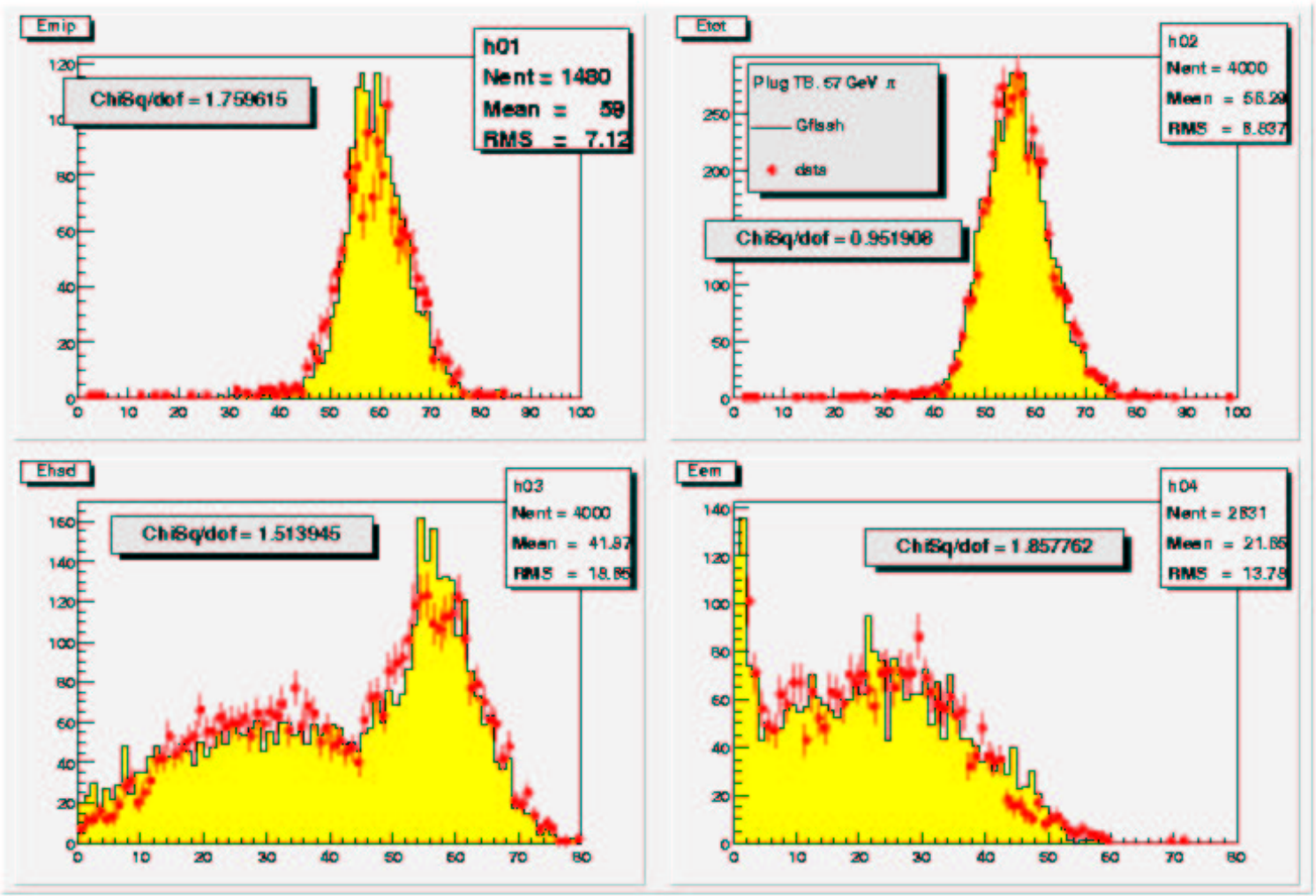


MIP peak in Central (57 GeV) and Plug (8 GeV)

57 GeV pions in Central Calorimeter (Soon)



57 GeV pions in Plug Calorimeter (Charles)



Future plans

- Tune the whole region in the central (.5-227 GeV)
- Generate γ + jets and/or di-jet events and compare with data
  - ϕ cracks
  - η cracks
  - Plug-vs-central response
  - EM/HAD in jets etc.
- Do γ-jet and/or di-jet balance in Monte Carlo

  Does this explain why the plug is different from the central calorimeter?

  If yes, we are ready to use the simulation to generate jets.
- Other necessary work:
  - Determine underlying event.
  - Continue on the jet absolute correction procedure.
  - Eventually, try to use the plug to improve the whole energy measurements.

Summary and Conclusions

- Progress has been made in checking the Energy scale of the calorimeters.
- The plug E-scale needs to be understood.
- The γ-jet and Z-jet (if we had enough events) balance procedures can be used to check initial jet corrections. As a starting point the run I corrections can be used and these data samples can provide the uncertainty on the jet energy scale. The uncertainty could be $< 10\%$, acceptable for the summer conferences.
- Work will have to continue to get correction with systematic errors comparable to run I (3% on absolute correction).
- Simulation tuning is proceeding well. We need more data at the low P_T end.

We meet on on-weeks Wednesdays, pump room 1:30 pm.
Coordinators: Anwar Bhatti, LG
Come and join us!!